US011851958B2

(12) **United States Patent**
Quero et al.

(10) **Patent No.: US 11,851,958 B2**
(45) **Date of Patent: Dec. 26, 2023**

(54) **SUPPORT STRUCTURE FOR GUIDE ARCH**

(71) Applicant: **HALLIBURTON ENERGY SERVICES, INC.**, Houston, TX (US)

(72) Inventors: **Philippe Quero**, Houston, TX (US); **Eric Bivens**, Littleton, CO (US)

(73) Assignee: **HALLIBURTON ENERGY SERVICES, INC.**, Houston, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 548 days.

(21) Appl. No.: **17/047,758**

(22) PCT Filed: **Dec. 4, 2019**

(86) PCT No.: **PCT/US2019/064518**
§ 371 (c)(1),
(2) Date: **Oct. 15, 2020**

(87) PCT Pub. No.: **WO2021/112844**
PCT Pub. Date: **Jun. 10, 2021**

(65) **Prior Publication Data**
US 2023/0151703 A1 May 18, 2023

(51) **Int. Cl.**
E21B 19/22 (2006.01)

(52) **U.S. Cl.**
CPC *E21B 19/22* (2013.01)

(58) **Field of Classification Search**
CPC E21B 19/22
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,799,731 A *	9/1998	Avakov	E21B 19/22 166/85.5
6,006,839 A *	12/1999	Dearing	E21B 19/22 166/85.5
7,036,578 B2 *	5/2006	Austbo	E21B 19/22 226/173
9,759,022 B2 *	9/2017	Andreychuk	E21B 7/023
2007/0209791 A1	9/2007	Havinga	
2008/0023227 A1	1/2008	Patton	
2009/0223677 A1 *	9/2009	Dreelan	E21B 19/22 242/615
2015/0101799 A1 *	4/2015	Steffenhagen	E21B 17/20 166/250.01
2018/0354742 A1	12/2018	Cooper et al.	
2019/0085647 A1 *	3/2019	Gubbins	E21B 19/22

FOREIGN PATENT DOCUMENTS

CN 102287151 A * 12/2011

OTHER PUBLICATIONS

International Search Report and Written Opinion of PCT/US2019/064518 dated Aug. 31, 2020.

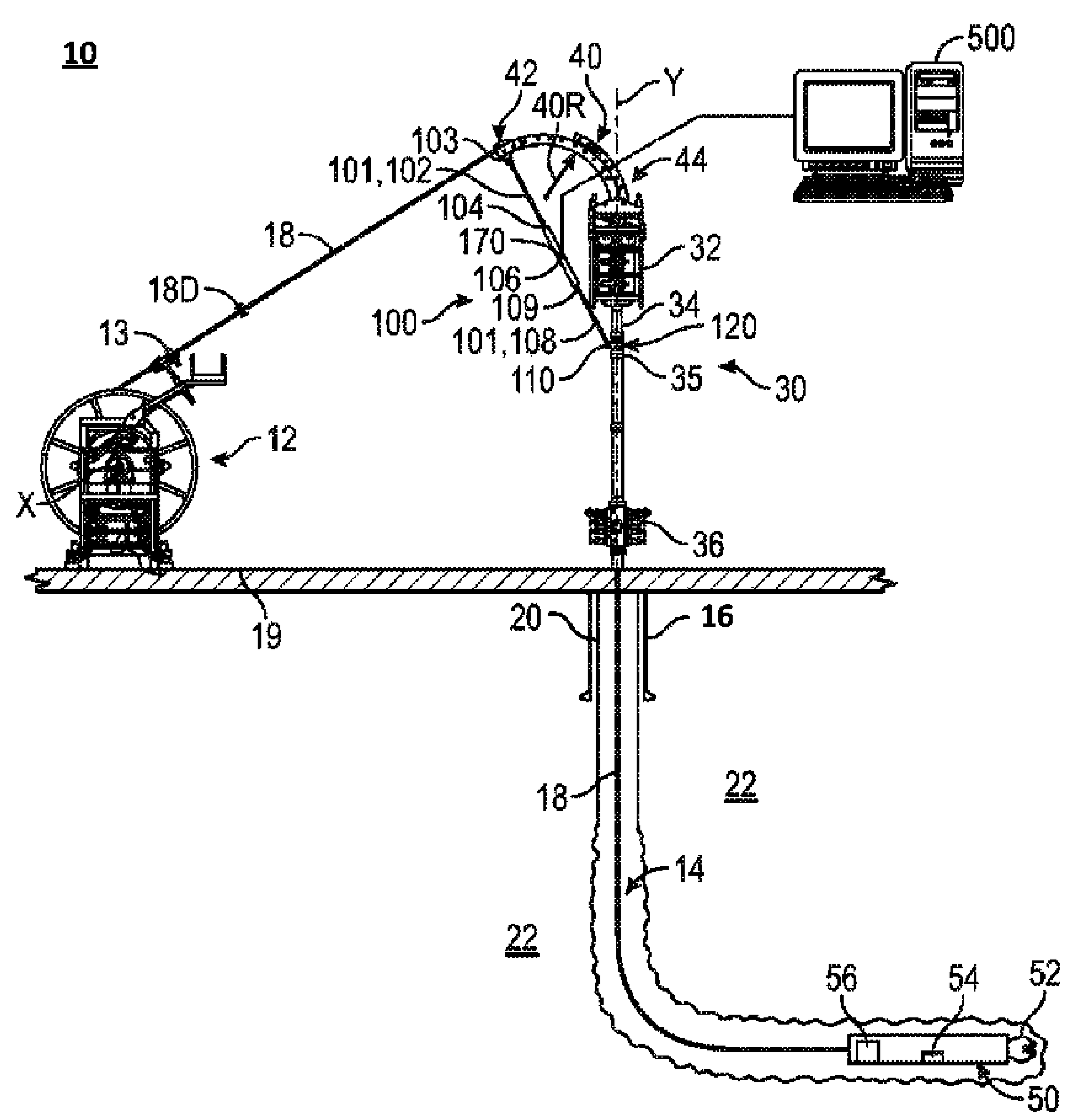
* cited by examiner

Primary Examiner — Matthew R Buck
(74) *Attorney, Agent, or Firm* — NOVAK DRUCE CARROLL LLP

(57) **ABSTRACT**

A pivoting guide arch is provided. The guide arch includes a guide having a curved portion to receive a coiled tube and to guide the tube as the tube traverses between a reel and a wellbore. The guide arch also includes a support structure extending from a first end of the guide that is configured to mechanically support the guide, and a swivel mount that is rotatably coupled to a wellhead to enable the guide and support structure to pivot about an axis of the wellhead.

20 Claims, 6 Drawing Sheets



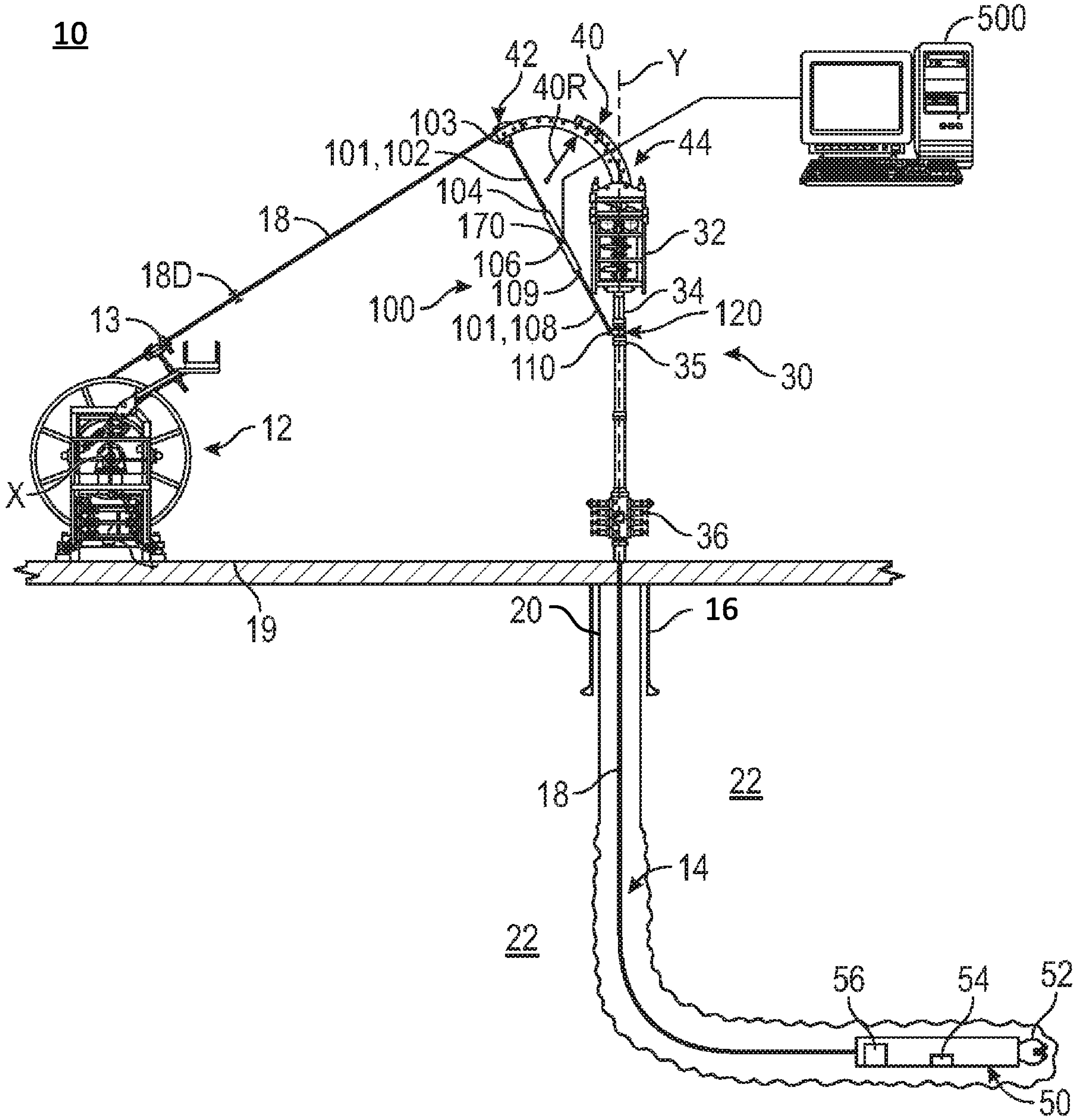

10
500
40
42
Y
40R
103
44
101,102
104
18
170
32
106
18D
109
34
100
101,108
120
13
110
35
30
12
X
36
19
20
16
22
18
14
22
56
54
52
50

FIG. 1

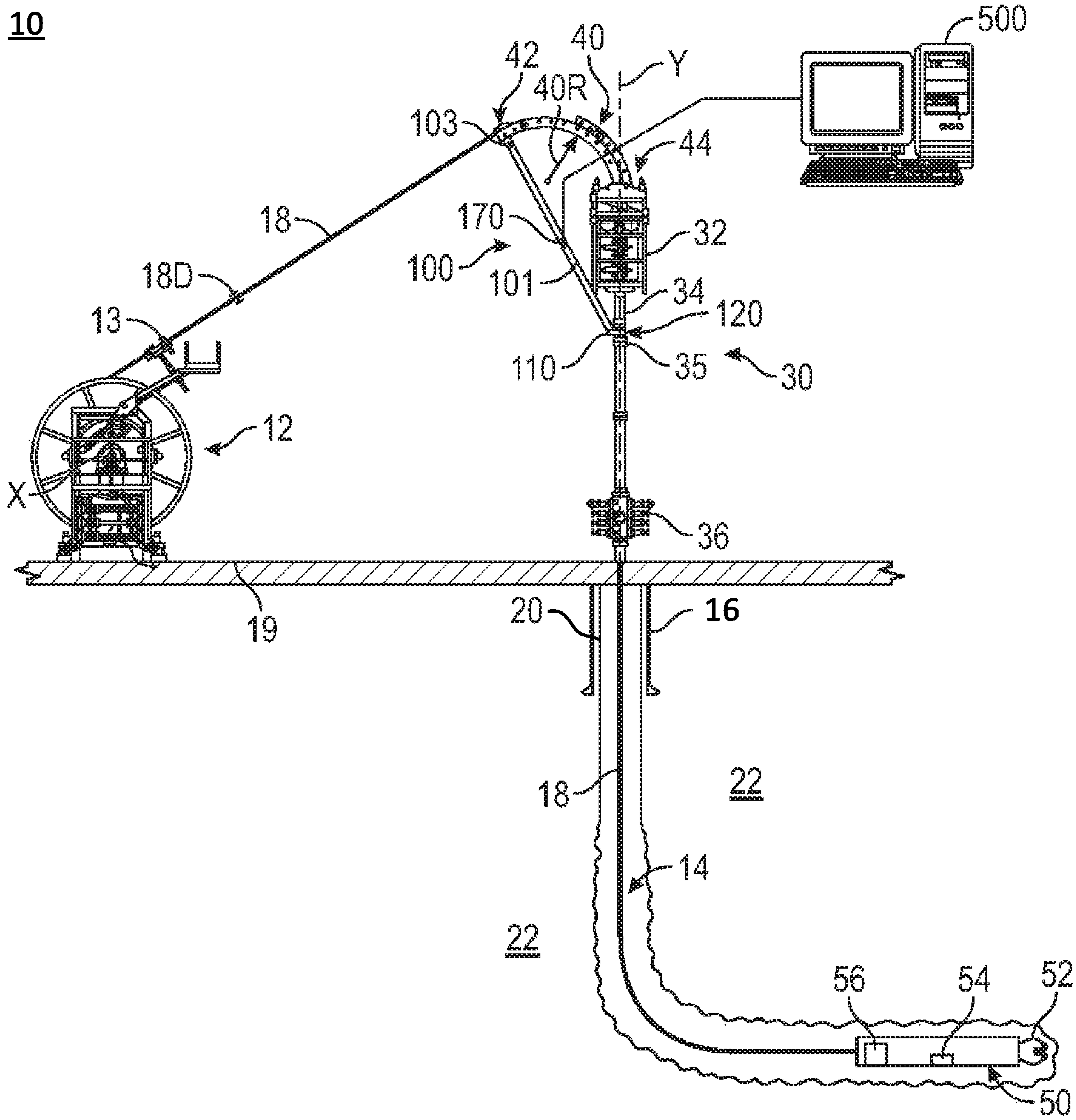

10
500
40
42
Y
40R
103
44
18
170
32
100
101
18D
34
120
13
110
35
30
12
X
36
19
20
16
18
22
14
22
56
54
52
50

FIG. 2

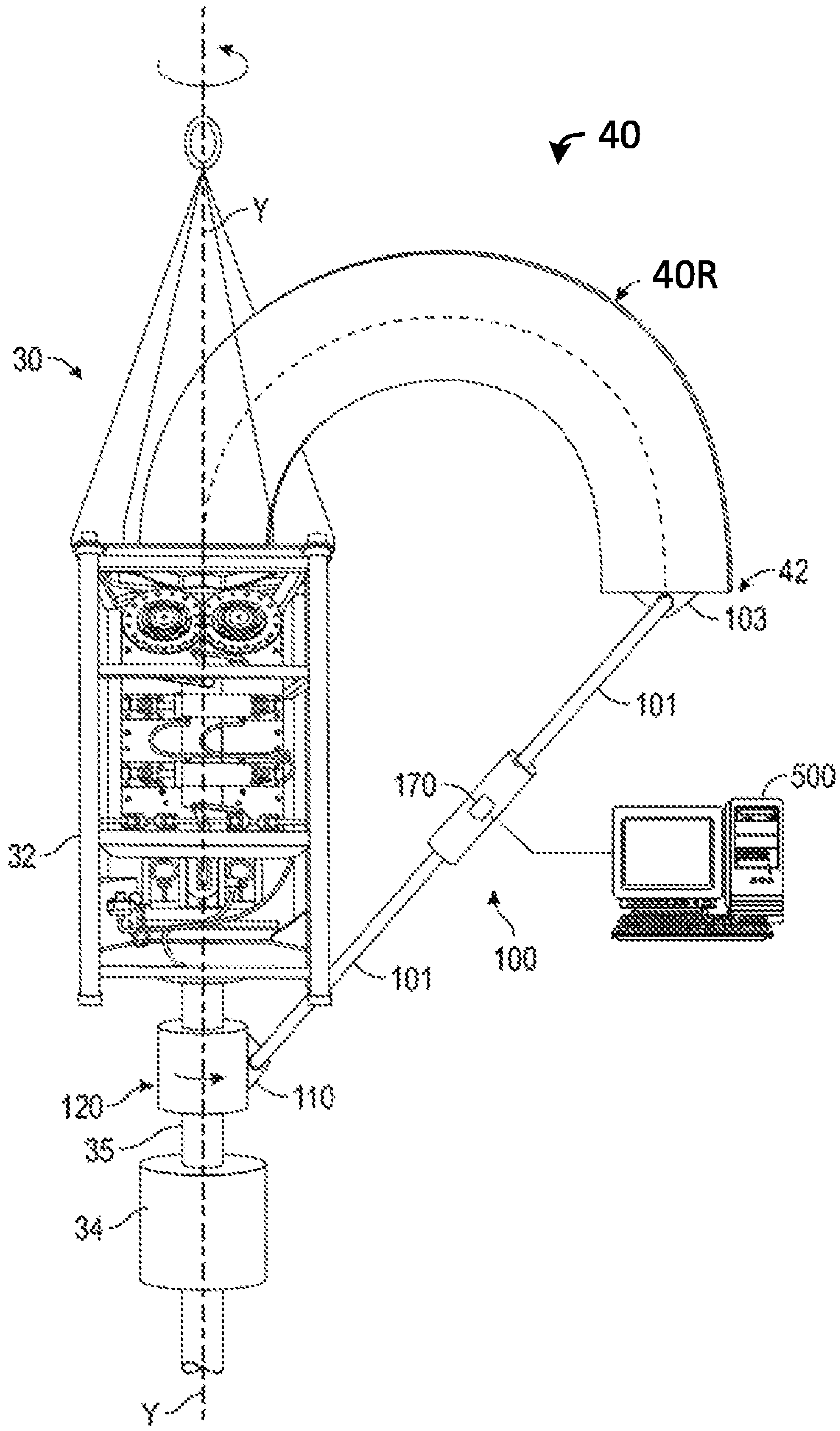


FIG. 3

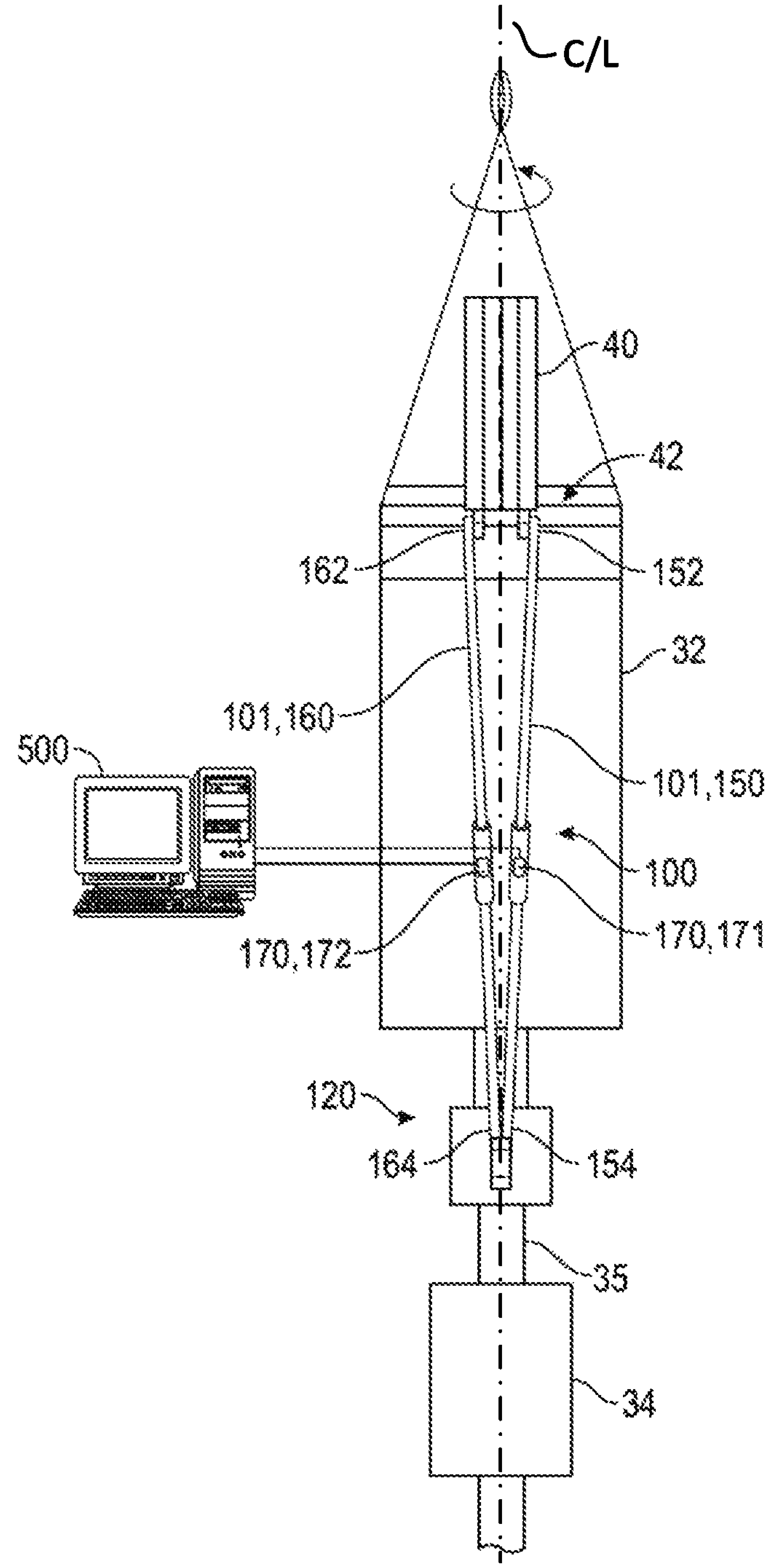

C/L
40
42
162
152
32
101,160
500
101,150
100
170,172
170,171
120
164
154
35
34

FIG. 4

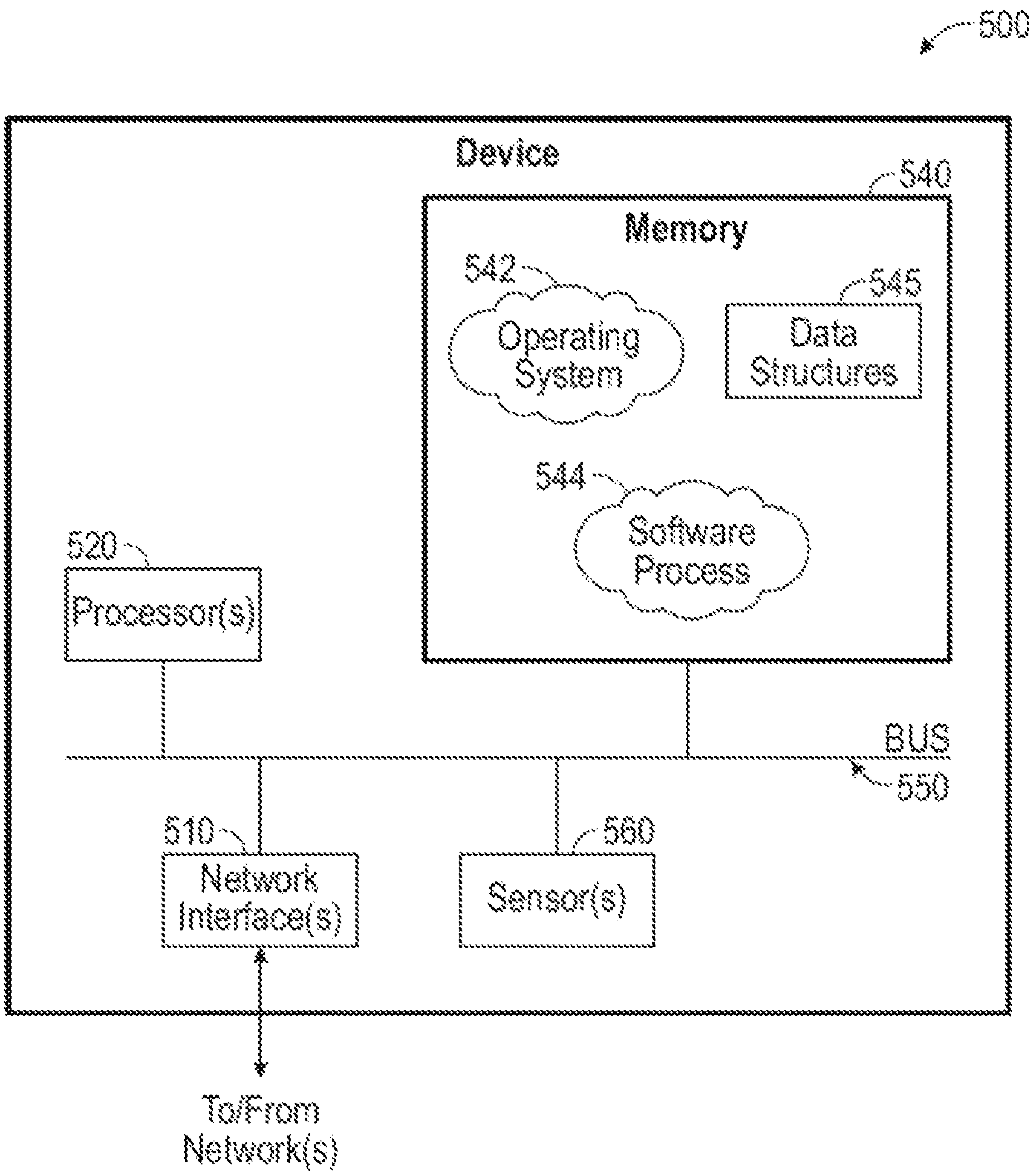

500
Device
540
Memory
542
Operating System
545
Data Structures
544
Software Process
520
Processor(s)
BUS
550
510
Network Interface(s)
560
Sensor(s)
To/From Network(s)

FIG. 5

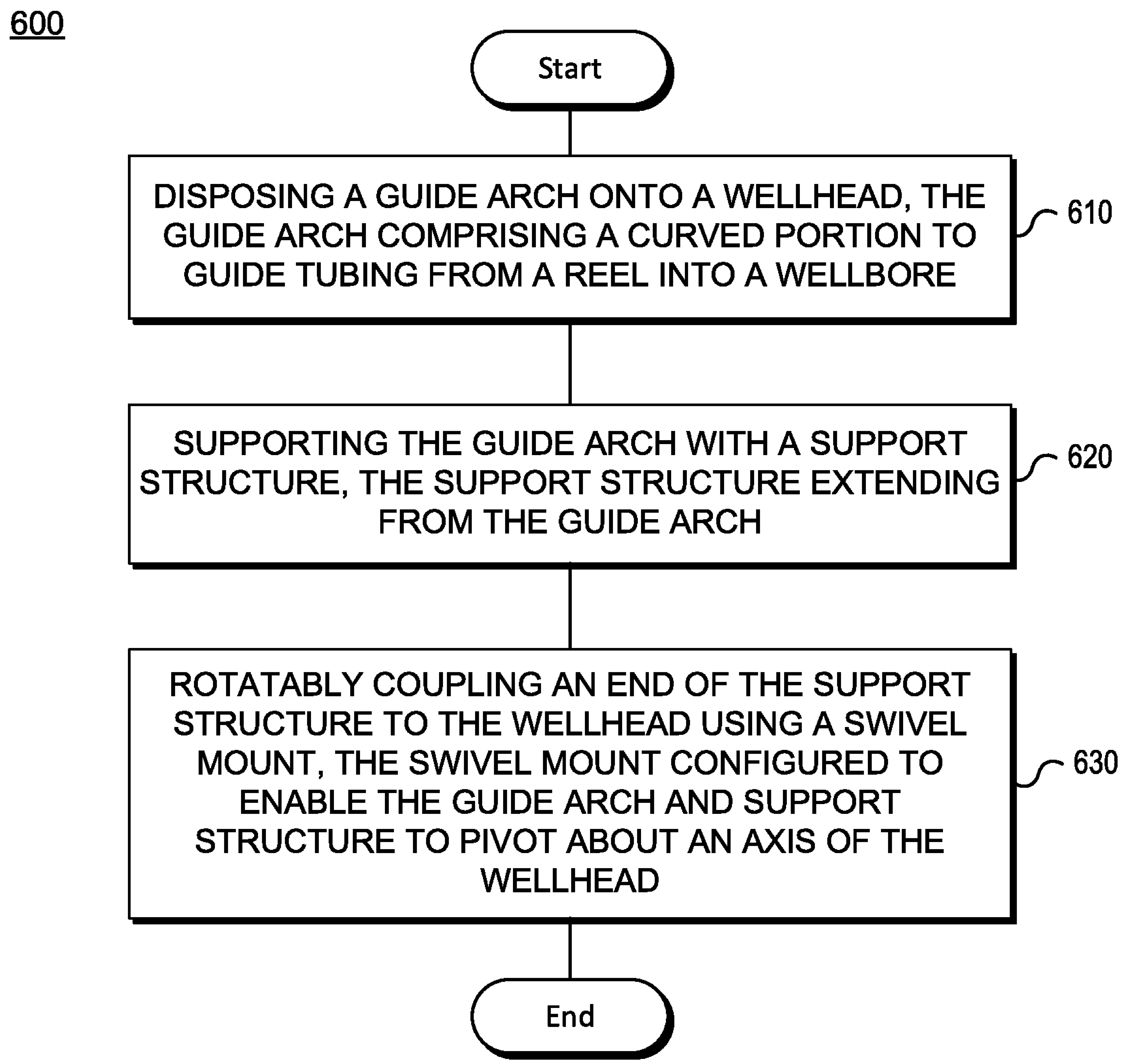

600
Start
DISPOSING A GUIDE ARCH ONTO A WELLHEAD, THE GUIDE ARCH COMPRISING A CURVED PORTION TO GUIDE TUBING FROM A REEL INTO A WELLBORE
610
SUPPORTING THE GUIDE ARCH WITH A SUPPORT STRUCTURE, THE SUPPORT STRUCTURE EXTENDING FROM THE GUIDE ARCH
620
ROTATABLY COUPLING AN END OF THE SUPPORT STRUCTURE TO THE WELLHEAD USING A SWIVEL MOUNT, THE SWIVEL MOUNT CONFIGURED TO ENABLE THE GUIDE ARCH AND SUPPORT STRUCTURE TO PIVOT ABOUT AN AXIS OF THE WELLHEAD
630
End

FIG. 6

SUPPORT STRUCTURE FOR GUIDE ARCH

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a national stage entry of PCT/US2019/064518 filed Dec. 4, 2019, said application is expressly incorporated herein by reference in its entirety.

TECHNICAL FIELD

The present disclosure relates generally to guide arches used in wellhead systems. In at least one example, the present disclosure relates to a pivoting and supported guide arch.

BACKGROUND

Wellbores are drilled into the earth for a variety of purposes including accessing hydrocarbon bearing formations. In conventional wells for the production of hydrocarbons, one or more cylindrical casings surround a smaller diameter production tubing through which the hydrocarbons will flow to the wellhead. Production tubing may utilize continuous tubing that is stored on a reel and installed or removed from the well using an injector. To guide the tubing from the reel and into the well, from a roughly horizontal or upwardly sloping direction as the tubing comes off the reel to a vertical direction required for downhole injection, a guide arch may be utilized.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to describe the manner in which the above-recited and other advantages and features of the disclosure can be obtained, a more particular description of the principles briefly described above will be rendered by reference to specific embodiments thereof which are illustrated in the appended drawings. Understanding that these drawings depict only exemplary embodiments of the disclosure and are not therefore to be considered to be limiting of its scope, the principles herein are described and explained with additional specificity and detail through the use of the accompanying drawings in which:

FIG. **1** is a diagram illustrating an exemplary environment for a wellhead utilizing a guide arch with an articulating support structure, in accordance with various aspects of the subject technology;

FIG. **2** is a diagram illustrating an exemplary environment for a wellhead utilizing a guide arch with a fixed support structure, in accordance with various aspects of the subject technology;

FIG. **3** is a diagram illustrating a perspective view of a guide arch, in accordance with various aspects of the subject technology;

FIG. **4** is a diagram illustrating a front view of a guide arch, in accordance with various aspects of the subject technology;

FIG. **5** illustrates an example of a controller, in accordance with various aspects of the subject technology; and

FIG. **6** is an example method for supporting tubing of a wellhead using a pivoting guide arch, in accordance with various aspects of the subject technology.

DETAILED DESCRIPTION

It will be appreciated that for simplicity and clarity of illustration, where appropriate, reference numerals have been repeated among the different figures to indicate corresponding or analogous elements. In addition, numerous specific details are set forth in order to provide a thorough understanding of the examples described herein. However, not all of the details may be necessary to practice the disclosed examples. In other instances, methods, procedures and components have been described so as not to obscure the related relevant feature being described. Also, the description is not to be considered as limiting the scope of the examples described herein. The drawings are not necessarily to scale and the proportions of certain parts may be exaggerated to better illustrate details and features.

Disclosed herein is a pivoting guide arch coupled to a wellhead. The pivoting guide arch includes a guide having a curved portion. The guide receives a conduit, such as coiled tubing, and guides the conduit along the curved portion into the wellhead, and subsequently into a wellbore. The guide is rotatably coupled to the wellhead such that the guide pivots about the axis of the wellhead. A support structure extends from the first end of the guide and mechanically supports the guide. The support structure provides support to the guide such that the guide can receive coiled tubing with a larger diameter, for example 2 inches. As the coiled tubing increases is size, the weight of the coiled tubing also increases. Accordingly, the support structure provides support to the guide to accommodate larger, heavier, coiled tubing.

A swivel mount is coupled to an end of the support structure opposite the guide and is rotatably coupled to the wellhead. Accordingly, the support structure can pivot about an axis of the wellhead along with the guide while also providing mechanical support to the guide.

FIG. **1** is a diagram illustrating an exemplary environment **10** for a wellhead **30** utilizing a guide arch **40** with an articulating support structure **100**, in accordance with various aspects of the subject technology. The exemplary environment **10** includes a wellhead **30** disposed on a surface **19** extending over and around a wellbore **14**. The wellbore **14** is within an earth formation **22** and, in at least one example, can have a casing **20** lining the wellbore **14**. The casing **20** can be held into place by cement **16**. In at least one example, the conduit **18** can be at least partially made of an electrically conductive material, for example steel. In another example, the conduit **18** can be at least partially made of a non-electrically conductive material, for example fiberglass or PEEK, or of a low-conductivity material, for example carbon composite, or a combination of such materials. A downhole tool **50** can be disposed within the wellbore **14** and moved down the wellbore **14** via a conduit **18** to a desired location. The conduit **18** may be coiled tubing. In other examples, the conduit **18** can be, for example, tubing-conveyed via a wireline, slickline, work string, joint tubing, jointed pipe, pipeline, and/or any other suitable means. The downhole tool **50** can include, for example, downhole sensors, chokes, and valves. The chokes and valves may include actuatable flow regulation devices, such as variable chokes and valves, and may be used to regulate the flow of the fluids into and/or out of the conduit **18**. The downhole tool **50** also includes a drill tool **52** to drill the wellbore **14** in the formation **22**. For example, the drill tool **52** can include a drill bit, a mill, and/or an auger. One or more assembly sensors **54** can be disposed in the downhole tool **50** and provide measurements and data of the wellbore **14**, the formation **22**, and/or the downhole tool **50**. For example, the assembly sensors **54** can include a directional sensor which can determine the direction that the downhole tool **50** is drilling in the formation **22**. In some examples, as illustrated in FIG. **1**, the downhole tool **50** can include a power source **56**. The power source **56** can provide power to the components of the downhole tool **50**, for example the assembly sensors **54** and/or a motor to actuate the drill tool **52**.

It should be noted that while FIG. **1** generally depicts a land-based operation, those skilled in the art would readily recognize that the principles described herein are equally applicable to operations that employ floating or sea-based platforms and rigs, without departing from the scope of the disclosure. Also, even though FIG. **1** depicts a vertical wellbore, the present disclosure is equally well-suited for use in wellbores having other orientations, including horizontal wellbores, slanted wellbores, multilateral wellbores or the like.

The wellhead **30** can include a blowout preventer **36**, a stripper **34**, and/or an injector **32**. The injector **32** can inject the conduit **18** into the wellbore **14**. For example, the conduit **18** can be stored in a reel **12** and when dispatched, may extend from the reel **12**, pass through the injector **32**, and into the wellbore **14**. In other examples, the injector **32** can pull the conduit **18** to retrieve the conduit **18** from the wellbore **14**. The stripper **34** can provide a pressure seal around the conduit **18** as the conduit **18** is being run into and/or pulled out of the wellbore **14**. The blowout preventer **36** can seal, control, and/or monitor the wellbore **14** to prevent blowouts, or uncontrolled and/or undesired release of fluids from the wellbore **14**. In other examples, different systems can be utilized based on the type of conduit **18** and/or the environment such as subsea or surface operations.

A guide arch **40** is mechanically coupled to the wellhead **30** to guide the conduit **18** from the reel **12** to the injector **32**. The guide arch **40** includes a curved portion **40**R that is configured to guide the conduit **18** as the conduit **18** transitions from a spooled or wound orientation along an X axis on the reel **12**, to a vertical or Y axis defined by a central axis of the wellbore **14**, wellhead **30**, or central axis of a component **35** (e.g., pipe, lubricator, stripper, or other component having a central axis) of the wellhead **30**. The curved portion **40**R of the guide arch **40** thus guides the conduit **18** as the conduit **18** travels along a first direction **13** extending from the reel **12**, to a second direction into or out of the wellbore **14**. In some examples, a radius of the curved portion **40**R may be greater than 96 inches to enable larger-diameter conduit **18** (for example, a conduit **18** having a diameter greater than 2 inches) to be used without causing excessive bending stresses on the conduit **18** due to insufficient curvature of the curved portion **40**R. In at least one example, the radius of the curved portion **40**R may be about 120 inches to about 160 inches. In other examples, the radius of the curved portion **40**R may be about 120 inches to about 180 inches. In other examples, the radius of the curved portion **40**R may not be continuous, and instead, may include a curvature having a progressive radius having more than one radius. By utilizing a curved portion **40**R having a radius of about 120 inches to about 180 inches, an outer diameter **18**D of the conduit **18** may be greater than 2 inches, such as a diameter **18**D in a range of about 2 inches to about 5 inches. The guide arch **40** is configured to receive the conduit **18** at a first end **42** and at a second end **44**, the guide arch **40** may be coupled to the injector **32**. The second end **44** of the guide arch **40** may be rotatably coupled to the wellhead **30** (for example, injector **32**) to enable the guide arch to rotate with respect to the injector **32**, wellbore **14**, wellhead **30**, and/or the Y axis.

A support structure **100** is coupled to the guide arch **40** to mechanically support the guide arch **400**. The support structure **100** extends from the first end **42** of the guide arch **40** and is rotatably coupled to the wellhead **30** via a swivel mount **120**. The support structure **100** may include one or more arms **101**. At a first end **103** of the arm **101**, the arm **101** is mechanically coupled to the first end **42** of the guide arch **40**. At a second end **110** of the arm **101**, the arm **101** is mechanically coupled to the swivel mount **120**. In at least one example, the support structure **100** may also include an actuator **106**, such as a hydraulic cylinder, having an upper arm **102** extending from a first end **104** of the actuator **106**, and a lower arm **108** extending from a second end **109** of the actuator **106**. The actuator **106** is configured to adjust a length of the support structure **100** as measured between the first end **103** and the second end **110** of the arm **101**. Such adjustment may be necessary to counter deflection of the first end **42** of the guide arch **40** that may be caused by a downward force applied by the conduit **18**. In other examples, the actuator **106** may be configured to apply a force against the guide arch **40** to counteract a load applied to the guide arch **40** by the conduit **18**. For example, a weight of the conduit **18** may apply excessive downward force to the first end **42** of the guide arch **40**, particularly where the conduit **18** includes a larger-diameter conduit having a diameter greater than 2 inches, thereby resulting with the guide arch **40** to shift so that the reel **12** and injector **32** become misaligned. The actuator **106** may be configured to apply an upward force to the first end **42** of the guide arch **40** to counter the downward force applied by the conduit **18**.

The swivel mount **120** is coupled to the second end **110** of the support structure **100**. The swivel mount **120** is rotatably coupled to the wellhead **30** to enable the guide arch **40** and the support structure **100** to pivot about the axis Y of the wellhead **30**. In at least one example, the swivel mount **100** may include a collar that is attached to a periphery of a component **35** of the wellhead **30**. In some examples, the swivel mount **100** may include a component of a lubricator. In yet other examples, the swivel mount **100** may include a flange that is configured to be clamped over an outer diameter of a component **35**. The swivel mount **120** may be rotatably coupled to the wellhead **30** between the stripper **34** and the blowout preventer **36**. Alternatively, the swivel mount **120** may be rotatably coupled to the wellhead **30** between the injector **32** and the stripper **34**, as shown in FIGS. **3** and **4**.

The swivel mount **120** is configured to allow the support structure **100** to rotate about the Y axis. In at least one example, the swivel mount **120** may be configured to allow the support structure **100** to rotate up to about 45 degrees about the Y axis. In another example, the swivel mount **120** may be configured to allow the support structure **100** to rotate up to about 90 degrees about the Y axis. In another example, the swivel mount **120** may be configured to allow the support structure **100** to rotate up to about 135 degrees about the Y axis. In another example, the swivel mount **120** may be configured to allow the support structure **100** to rotate up to about 180 degrees about the Y axis. In another example, the swivel mount **120** may be configured to allow the support structure **100** to rotate up to about 270 degrees about the Y axis. In yet another example, the swivel mount **120** may be configured to allow the support structure **100** to rotate up to about 360 degrees about the Y axis.

In some examples, the support structure **100** may further include a sensor **170** configured to measure at least one of a strain, load and force acting on the guide arch **40** and/or the arm **101**. The sensor **170** may include at least one of a load cell and a strain gauge. The sensor **170** may be communicatively coupled to a controller **500** to provide data representing one of at least a strain, load and force acting on the guide arch **40** and/or the arm **101** to the controller **500**. The controller **500** may be configured to receive the data from the sensor **170**, process the data from the sensor **170**, and determine whether to adjust a length of the actuator **106** to either lengthen or shorten a length of the arm **101**, and/or to apply a force against the guide arch **40** to counter a load acting upon the guide arch **40**. For example, when the sensor **170** measures a load acting upon the guide arch **40** that exceeds a predetermined threshold for deflection of the guide arch **40**, the controller **500** may transmit a control signal to the actuator **106** to apply a force or load against the guide arch **40** to counter the measured load and reduce or eliminate the deflection of the guide arch caused by the conduit **18**.

FIG. **2** is a diagram illustrating an exemplary environment **10** for a wellhead **30** utilizing a guide arch **40** with a fixed support structure **100**, in accordance with various aspects of the subject technology. In at least one example, the support structure **100** may include an arm **101** having a first end **103** coupled to the guide arch **40** and a second end **110** coupled to the swivel mount **120**. Disposed on the arm **101** is the sensor **170** that measures at least one of a strain, load and force acting on the arm **101**. The sensor **170** may be communicatively coupled to the controller **500** to process data provided by the sensor **170** to determine whether a length of the arm **101** should be adjusted, speed of the reel **12** should be adjusted, or to otherwise adjust operations of the wellhead **30** to prevent failure or over-loading of the conduit **18** and/or guide arch **40**.

As described above with reference to FIG. **1**, the conduit **18** (for example, coiled tubing) is disposed in the wellbore **14**. The conduit **18** is stored on the reel **12** and is guided from the reel **12** to the wellhead **30** by the guide arch **40**. The guide arch **40** includes the curved portion **40**R that is configured to receive the conduit **18** at the first end **42** of the guide arch **40**, and guide the conduit **18** along the curved portion **40**R and into the wellbore **14**. To enable the guide arch **40** to pivot or rotate with respect to the wellhead **30**, the guide arch **40** is rotatably coupled to the wellhead at the second end **44** of the guide arch **40**. The guide arch **40** further includes the support structure **100** to mechanically support the guide arch **40**. The support structure is coupled to the first end **42** of the guide arch **40** at the first end **103** of the arm **101**. The guide arch **40** further includes the swivel mount **120** that is coupled to the second end **110** of the arm **101** and is rotatably coupled to the wellhead **30** to enable the guide arch **40** and support structure **100** to pivot about the Y axis of the wellhead **30**.

In at least one example, the arm **101** of the support structure **100** may include a telescoping tube that is configured to have its length adjusted through use of fasteners inserted through one of a plurality of holes that are spaced apart to enable adjustment of the length of the arm **101**. The arm **101** may include other profiles, such as angles, I-beams, C-channels, etc. that may be configured to have an adjustable length based on a particular arrangement of fasteners and mounting holes or slots.

FIG. **3** is a diagram illustrating a perspective view of a guide arch **40**, in accordance with various aspects of the subject technology. In at least one example, the guide arch **40** may be coupled or fastened to the injector **32** such that the guide arch **40**, injector **32**, and support structure **100** rotate as an assembly about the Y axis via the swivel mount **120**.

In at least one example, because the second end **110** of the arm **101** of the support structure **100** is attached to the wellhead **30** below the injector **32**, a center of gravity of the injector **32**, guide arch **40**, and support structure **100** is shifted closer to the Y axis resulting in a more stabilized assembly during lifting and manipulation of the assembly via a hoist or harness. In other words, because the first end **103** of the arm **101** of the support structure **100** is coupled to the first end **42** of the guide arch **40**, and the second end **110** of the arm **101** is coupled to the wellhead **30** at a location below the injector **32**, a portion of a weight of the guide arch **40** is shifted to the swivel mount **120** at the second end **110** of the arm **101** to thereby shift the center of gravity of the injector **32**, guide arch **40**, and support structure **100** to be closer to the Y axis than would otherwise without the support structure **100**.

Shifting the center of gravity of the injector **32**, guide arch **40**, and support structure **100** to be closer to the Y axis eases installation of the assembly onto the component **35** of the wellhead **30** because the assembly, when lifted by an overhead hoist, is better aligned with the component **35**. As shown in FIG. **3**, the injector **32**, guide arch **40**, support structure **100**, and the swivel mount **120** may be installed on the component **35**, above the stripper **34**. In the example illustrated in FIG. **3**, the swivel mount **120** is disposed between the injector **32** and the stripper **34**.

FIG. **4** is a diagram illustrating a front view of a guide arch **40**, in accordance with various aspects of the subject technology. In at least one example, the support structure **100** may include a first arm **150** and a second arm **160**. A first end **152** of the first arm **150** is attached to the first end **42** of the guide arch **40**. A first end **162** of the second arm **160** is attached to the first end **42** of the guide arch **40**. A second end **154** of the first arm **150** is attached to the swivel mount **120**. A second end **164** of the second arm **160** is attached to the swivel mount **120**. In at least one example, the first arm **150** and the second arm **160** may form a v-shape, with a common joint at the second ends, **154** and **164** respectively. As shown, the arms **101** are arranged so that they intersect a centerline ("C/L") of the wellhead **30**, injector **32**, stripper **34** and/or component By mounting the second ends, **154** and **164** respectively, of the support arms **101** in the same plane as the centerline, versus mounting the support arms **101** to a corner or side of the injector frame **32**, the guide arch **40** is capable of pivoting more easily while also better distributing the weight of the guide arch **40** to the centerline, instead of at an off-center point on the wellhead **30**.

Each arm **101** may have a sensor **170** disposed thereon. For example, the first arm **150** may have a first sensor **171** and the second arm **160** may have a second sensor **172**. The first and second sensors, **171** and **172** respectively, may be communicatively coupled to the controller **500** to provide at least one of a strain, load and force acting upon the corresponding first and second arms, **150** and **160** respectively, to the controller **500**. In other examples, only one of the arms **101** may include a sensor **170**.

FIG. **5** illustrates an example of a controller **500**, in accordance with various aspects of the subject technology. Controller **500** is configured to perform processing of data and communicate with the sensor **170**, for example as illustrated in FIGS. **1-4**. In operation, controller **500** communicates with one or more of the above-discussed components and may also be configured to communicate with remote devices/systems.

As shown, controller **500** includes hardware and software components such as network interfaces **510**, at least one processor **520**, sensors **560** and a memory **540** interconnected by a system bus **550**. Network interface(s) **510** can include mechanical, electrical, and signaling circuitry for communicating data over communication links, which may include wired or wireless communication links. Network interfaces **510** are configured to transmit and/or receive data using a variety of different communication protocols, as will be understood by those skilled in the art.

Processor **520** represents a digital signal processor (e.g., a microprocessor, a microcontroller, or a fixed-logic processor, etc.) configured to execute instructions or logic to perform tasks in a wellbore environment. Processor **520** may include a general purpose processor, special-purpose processor (where software instructions are incorporated into the processor), a state machine, application specific integrated circuit (ASIC), a programmable gate array (PGA) including a field PGA, an individual component, a distributed group of processors, and the like. Processor **520** typically operates in conjunction with shared or dedicated hardware, including but not limited to, hardware capable of executing software and hardware. For example, processor **520** may include elements or logic adapted to execute software programs and manipulate data structures **545**, which may reside in memory **540**.

Sensors **560**, which may include sensor **170** as disclosed herein, typically operate in conjunction with processor **520** to perform measurements, and can include special-purpose processors, detectors, transmitters, receivers, and the like. In this fashion, sensors **560** may include hardware/software for generating, transmitting, receiving, detection, logging, and/or sampling magnetic fields, seismic activity, and/or acoustic waves, temperature, pressure, radiation levels, casing collar locations, weights, torques, tool health (such as voltage levels and current monitors), accelerations, gravitational fields, strains, video recordings, flow rates, solids concentration, solids size, chemical composition, and/or other parameters.

Memory **540** comprises a plurality of storage locations that are addressable by processor **520** for storing software programs and data structures **545** associated with the embodiments described herein. An operating system **542**, portions of which may be typically resident in memory **540** and executed by processor **520**, functionally organizes the device by, inter alia, invoking operations in support of software processes and/or services **544** executing on controller **500**. These software processes and/or services **544** may perform processing of data and communication with controller **500**, as described herein. Note that while process/service **544** is shown in centralized memory **540**, some examples provide for these processes/services to be operated in a distributed computing network.

It will be apparent to those skilled in the art that other processor and memory types, including various computer-readable media, may be used to store and execute program instructions pertaining to the fluidic channel evaluation techniques described herein. Also, while the description illustrates various processes, it is expressly contemplated that various processes may be embodied as modules having portions of the process/service **544** encoded thereon. In this fashion, the program modules may be encoded in one or more tangible computer readable storage media for execution, such as with fixed logic or programmable logic (e.g., software/computer instructions executed by a processor, and any processor may be a programmable processor, programmable digital logic such as field programmable gate arrays or an ASIC that comprises fixed digital logic. In general, any process logic may be embodied in processor **520** or computer readable medium encoded with instructions for execution by processor **520** that, when executed by the processor, are operable to cause the processor to perform the functions described herein.

FIG. **6** is an example method **600** for supporting tubing of a wellhead using a pivoting guide arch, in accordance with various aspects of the subject technology. The method **600** is provided by way of example, as there are a variety of ways to carry out the method. The method **600** described below can be carried out using the configurations illustrated in FIGS. **1-5**, for example, and various elements of these figures are referenced in explaining example method **600**. Each block shown in FIG. **6** represents one or more processes, methods or subroutines, carried out in the example method **600**. Furthermore, the illustrated order of blocks is illustrative only and the order of the blocks can change according to the present disclosure. Additional blocks may be added or fewer blocks may be utilized, without departing from this disclosure. The method **600** can begin at block **610**.

At block **610**, a guide arch is disposed onto a wellhead. The guide arch includes a curved portion to guide tubing from a reel into a wellbore. At block **620**, the guide arch is supported with a support structure. The support structure extends from the guide arch to the wellhead so that the guide arch is mechanically supported by an arm extending from a first end of the guide arch to a point on the wellhead that is below an injector. The injector is configured to move the tubing into and out of the wellbore. At block **630**, an end of the support structure is rotatably coupled to the wellhead using a swivel mount. The swivel mount enables the guide arch and support structure to pivot about an axis of the wellhead. The axis may be a center axis of the wellhead, wellbore, or a component of the wellheads, such as a pipe, lubricator, injector, or other component having an opening through which fluid flows.

The method may also include measuring at least one of a strain, load and force using a sensor disposed on the support structure. The sensor may be communicatively coupled to a controller to provide data representing at least one of a strain, load and force acting on the support structure, to the controller. In response, the controller may be configured to process the data and determine that an actuator of the support structure requires adjustment. For example, if the sensor detects a load that exceeds a predetermined amount indicative of deflection that is outside a predetermined range, the controller may send a signal to cause the actuator to apply a force or load against the guide arch to counter the load being applied to the guide arch so that continual deflection of the guide arch is minimized, prevented, or reversed. In another example, data from the sensor representing strain on the guide arch may be utilized by the controller to inform an operator that the guide arch may be overloaded, thereby enabling the operator to take actions to reduce the load on the guide arch, by for example, moving the injector with respect to the reel.

As described above, the swivel mount enables the guide arch and injector to pivot about the axis so that the guide arch may self-align to the reel storing the tubing. As the tubing is unreeled from the reel, a side to side motion of the tubing as the tubing tracks along the reel causes the guide arch and injector to pivot about the swivel mount to reduce or eliminate a side load acting on the guide arch. In other words, the swivel mount enables the guide arch to maintain a more direct angle of approach over conventional guide arches that are not capable of pivoting. By reducing the side load on the tubing, wear on the tubing is reduced or minimized thereby extending the lifespan or longevity of the tubing. In another example, by allowing the guide arch and injector to pivot about the axis, the likelihood of the tubing slipping off of the guide arch is also minimized or eliminated because the guide arch is capable of self-aligning with the tubing as the tubing tracks from side to side along the reel.

In yet another example, the swivel mount enables the injector and the guide arch to pivot about the Y axis to align with a different reel when necessary, without requiring movement of the reel. Alignment of the injector and guide arch with respect to a particular reel is handled by the swivel mount, in that the injector and the guide arch can be rotated as a unit, toward the desired reel without having to move the reel into alignment with the injector.

In some examples, the support structure is configured to mechanically support the guide arch so that the guide arch is capable of handling larger-diameter tubing, such as tubing having an outside diameter exceeding 2 inches. By transferring a load acting upon the first end of the guide arch to another portion of the wellhead (e.g., to a section of the wellhead in contact with the swivel mount), a load capacity of the guide arch is increased. In yet another example, because the support structure connects the first end of the guide arch to a portion of the wellhead below the injector, a center of gravity of the guide arch, injector and support structure is shifted to be closer to the axis, thereby making lifting and handling of the assembly easier when lifted overhead, such as during installation or removal of the assembly from the wellhead.

Numerous examples are provided herein to enhance understanding of the present disclosure. A specific set of statements are provided as follows.

Statement 1: A pivoting guide arch comprising: a guide including a curved portion, the guide receiving a coiled tubing at a first end, and guiding the coiled tubing along the curved portion to change a direction of the coiled tubing; a support structure extending from the first end of the guide and mechanically supporting the guide; and a swivel mount coupled to an end of the support structure, the swivel mount rotatably coupled to a wellhead to enable the guide and support structure to pivot about an axis of the wellhead.

Statement 2: A pivoting guide arch is disclosed according to Statement 1, wherein a second end of the guide is rotatably coupled to the wellhead such that the guide pivots about the axis of the wellhead.

Statement 3: A pivoting guide arch is disclosed according to Statements 1 or 2, wherein the support structure includes a first arm and a second arm, the first and second arms forming a v-shape.

Statement 4: A pivoting guide arch is disclosed according to any of preceding Statements 1-3, wherein the support structure includes an actuator to adjust a length of the support structure.

Statement 5: A pivoting guide arch is disclosed according to any of preceding Statements 1-4, wherein the support structure includes an actuator to apply a force against the guide to counteract a load applied to the guide.

Statement 6: A pivoting guide arch is disclosed according to any of preceding Statements 1-5, wherein the support structure includes a sensor to measure at least one of a strain, load, and force.

Statement 7: A pivoting guide arch is disclosed according to any of preceding Statements 1-6, wherein the sensor includes at least one of a load cell and a strain gauge.

Statement 8: A pivoting guide arch is disclosed according to any of preceding Statements 1-7, wherein the sensor is communicatively coupled to a controller, the controller adjusting the actuator based on data supplied by the sensor.

Statement 9: A wellhead system is disclosed comprising: a coiled tube configured to be disposed in a wellbore; a reel storing the coiled tube; a guide arch including a curved portion, the guide arch receiving the coiled tube at a first end, and guiding the tube along the curved portion and into the wellbore, the guide arch rotatably coupled to a wellhead at a second end; a support structure extending from the first end of the guide arch and mechanically supporting the guide arch; and a swivel mount coupled to an end of the support structure, the swivel mount rotatably coupled to the wellhead to enable the guide arch and support structure to pivot about an axis of the wellhead.

Statement 10: A wellhead system is disclosed according to Statement 9, wherein the support structure includes an actuator to adjust a length of the support structure.

Statement 11: A wellhead system is disclosed according to Statements 9 or 10, wherein the support structure includes an actuator to apply a force against the guide arch to counteract a load applied to the guide arch.

Statement 12: A wellhead system is disclosed according to any of preceding Statements 9-11, wherein the support structure includes a sensor to measure at least one of a strain, load, and force.

Statement 13: A wellhead system is disclosed according to any of preceding Statements 9-12, wherein the sensor is communicatively coupled to a controller, the controller adjusting the actuator based on data supplied by the sensor.

Statement 14: A wellhead system is disclosed according to any of preceding Statements 9-13, wherein the wellhead includes an injector, a stripper disposed below the injector, and a blowout preventer disposed below the stripper; wherein the swivel mount is rotatably coupled to the wellhead between the stripper and the blowout preventer.

Statement 15: A wellhead system is disclosed according to any of preceding Statements 9-14, wherein the wellhead comprises an injector, a stripper disposed below the injector, and a blowout preventer disposed below the stripper; wherein the swivel mount is rotatably coupled to the wellhead between the injector and the stripper.

Statement 16: A wellhead system is disclosed according to any of preceding Statements 9-15, wherein the coiled tube has an outer diameter in a range of about 2 inches to about 5 inches

Statement 17: A wellhead system is disclosed according to any of preceding Statements 9-16, wherein the curved portion of the guide arch has a radius in a range of about 120 inches to about 180 inches.

Statement 18: A method for supporting tubing of a wellhead using a pivoting guide arch is disclosed comprising: disposing a guide arch onto a wellhead, the guide arch including a curved portion to guide tubing from a reel into a wellbore; supporting the guide arch with a support structure, the support structure extending from the guide arch; and rotatably coupling an end of the support structure to the wellhead using a swivel mount, the swivel mount enabling the guide arch and support structure to pivot about an axis of the wellhead.

Statement 19: A method is disclosed according to Statement 18, further comprising: measuring, by a sensor disposed on the support structure, at least one of a strain, load, and force.

Statement 20: A method is disclosed according to Statements 18 or 19, further comprising: adjusting an actuator of the support structure based on data supplied by the sensor.

The embodiments shown and described above are only examples. Even though numerous characteristics and advantages of the present technology have been set forth in the foregoing description, together with details of the structure and function of the present disclosure, the disclosure is illustrative only, and changes may be made in the detail, especially in matters of shape, size and arrangement of the parts within the principles of the present disclosure to the full extent indicated by the broad general meaning of the terms used in the attached claims. It will therefore be appreciated that the examples described above may be modified within the scope of the appended claims.

What is claimed is:

1. A pivoting guide arch comprising:

a guide including a curved portion, the guide receiving a coiled tubing at a first end, and guiding the coiled tubing along the curved portion to change a direction of the coiled tubing;

a support structure extending from the first end of the guide and mechanically supporting the guide; and

a swivel mount coupled to an end of the support structure, the swivel mount rotatably coupled to a wellhead to enable the guide and the support structure to pivot about an axis of the wellhead, wherein the swivel mount is detached from an injector and positioned below the injector.

2. The pivoting guide arch of claim **1**, wherein a second end of the guide is rotatably coupled to the wellhead such that the guide pivots about the axis of the wellhead.

3. The pivoting guide arch of claim **1**, wherein the support structure includes a first arm and a second arm, the first and second arms forming a v-shape.

4. The pivoting guide arch of claim **1**, wherein the support structure includes an actuator to adjust a length of the support structure.

5. The pivoting guide arch of claim **1**, wherein the support structure includes an actuator to apply a force against the guide to counteract a load applied to the guide.

6. The pivoting guide arch of claim **5**, wherein the support structure includes a sensor to measure at least one of a strain, load, and force.

7. The pivoting guide arch of claim **6**, wherein the sensor includes at least one of a load cell and a strain gauge.

8. The pivoting guide arch of claim **6**, wherein the sensor is communicatively coupled to a controller, the controller adjusting the actuator based on data supplied by the sensor.

9. A wellhead system comprising:

a coiled tube configured to be disposed in a wellbore;

a reel storing the coiled tube;

a guide arch including a curved portion, the guide arch receiving the coiled tube at a first end, and guiding the tube along the curved portion and into the wellbore, the guide arch rotatably coupled to a wellhead at a second end;

a support structure extending from the first end of the guide arch and mechanically supporting the guide arch; and

a swivel mount coupled to an end of the support structure, the swivel mount rotatably coupled to the wellhead to enable the guide arch and support structure to pivot about an axis of the wellhead, wherein the swivel mount is detached from an injector and positioned below the injector.

10. The wellhead system of claim **9**, wherein the support structure includes an actuator to adjust a length of the support structure.

11. The wellhead system of claim **9**, wherein the support structure includes an actuator to apply a force against the guide arch to counteract a load applied to the guide arch.

12. The wellhead system of claim **11**, wherein the support structure includes a sensor to measure at least one of a strain, load, and force.

13. The wellhead system of claim **12**, wherein the sensor is communicatively coupled to a controller, the controller adjusting the actuator based on data supplied by the sensor.

14. The wellhead system of claim **9**, wherein the wellhead includes the injector, a stripper disposed below the injector, and a blowout preventer disposed below the stripper; wherein the swivel mount is rotatably coupled to the wellhead between the stripper and the blowout preventer.

15. The wellhead system of claim **9**, wherein the wellhead includes the injector, a stripper disposed below the injector, and a blowout preventer disposed below the stripper; wherein the swivel mount is rotatably coupled to the wellhead between the injector and the stripper.

16. The wellhead system of claim **9**, wherein the coiled tube has an outer diameter in a range of about 2 inches to about 5 inches.

17. The wellhead system of claim **9**, wherein the curved portion of the guide arch has a radius in a range of about 120 inches to about 180 inches.

18. A method to support tubing of a wellhead using a pivoting guide arch, the method comprising:

disposing a guide arch onto a wellhead, the guide arch including a curved portion to guide tubing from a reel into a wellbore;

supporting the guide arch with a support structure, the support structure extending from the guide arch; and

rotatably coupling an end of the support structure to the wellhead using a swivel mount, the swivel mount enabling the guide arch and support structure to pivot about an axis of the wellhead, wherein the swivel mount is detached from an injector and positioned below the injector.

19. The method of claim **18**, further comprising: measuring, by a sensor disposed on the support structure, at least one of a strain, load, and force.

20. The method of claim **19**, further comprising: adjusting an actuator of the support structure based on data supplied by the sensor.

* * * * *